PROCESS ENGINEERING INC.
PLAISTOW, NH 03865

CRYOGENIC CONVERTERS.

T.O. 37C2-8-37-1

OPERATING AND MAINTENANCE MANUAL

Model H-3110-7-70
3000 Gallon Liquid Oxygen and Nitrogen Storage Tank
For
United States Air Force
Kelly AFB, Kelly, Texas

Contract #F41608-94-D-0647
Commercial Manual T.O. 37C2-8-37-1

MFR #05125

NSN #3655-01-391-9281YD (OXYGEN)
NSN #3655-01-396-3099YD (NITROGEN)

Process Engineering
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Spare Parts

1 July 1994

Issue Date

PROCESS ENGINEERING INC.
PLAISTOW, NH. 03865

CRYOGENIC STORAGE TANKS

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JULY 1994

Issue Date

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SAFETY DATA SHEET

WARNING

Liquid Oxygen and its vapors are extremely cold and can rapidly freeze human tissue and cause many common materials such as carbon steel, plastic, and rubber to become brittle or even fracture under stress.

Liquid Oxygen at its boiling point at 1 atmosphere has a temperature of -297°F (183°C) and must be handled with properly designed containers. Liquid Oxygen has a high liquid to gas expansion ratio of 860 to 1. If liquid Oxygen is allowed to vaporize in a sealed container or in a closed section of piping enormous pressure will be generated.

Oxygen is non-flammable, but it vigorously accelerates combustion. Substances that burn in air will burn much more vigorously in Oxygen:

- Keep all combustible materials, especially oil or grease, away from Oxygen.
- Do not smoke or permit an open flame in any area where liquid Oxygen is stored or handled.

Accidental contact of liquid Oxygen with skin or eyes may cause a freezing injury similar to a burn. Protect eyes and skin while handling liquid Oxygen or where contact with cold pipes/valves exists. Use of clean, insulated gloves and long sleeve shirts is recommended. Cuffless pants should be worn over boots or shoes to shed spilled liquid.

If clothing should become saturated with liquid Oxygen or vapors, remove if possible and let clothing air out for a minimum of 30 minutes.

SAFETY DATA SHEET

WARNING

Liquid Nitrogen and its vapors are extremely cold and can rapidly freeze human tissue and cause many common materials such as carbon steel, plastic, and rubber to become brittle or even fracture under stress.

Liquid Nitrogen at its boiling point of 1 atmosphere has a temperature of -320°F (196°C) and must be handled with properly designed containers. Liquid Nitrogen has a high liquid to gas expansion ratio of 696 to 1. If liquid Nitrogen is allowed to vaporize in a sealed container or in a closed section of piping, enormous pressure will be generated.

Nitrogen vapors may dilute or displace the concentration of Oxygen necessary to support or sustain life. Exposure to such an Oxygen deficient atmosphere can lead to unconsciousness and serious injury, including death.

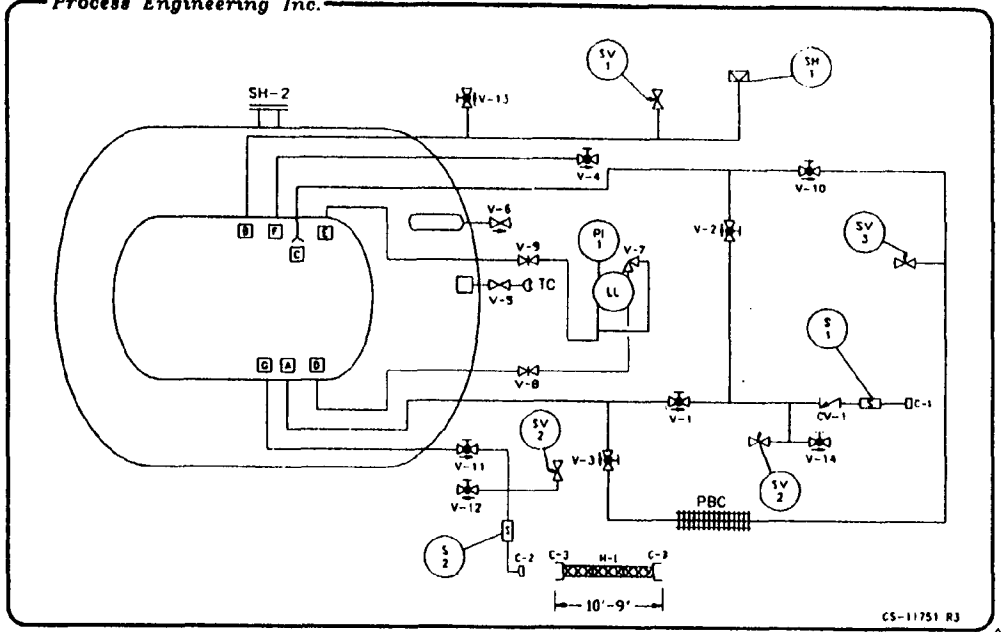
Accidental contact of liquid Nitrogen with skin or eyes may cause a freezing injury similar to a burn. Protect eyes and skin while handling liquid Nitrogen or where contact with cold pipes/valves exist. Use of clean, insulated gloves and long sleeve shirts is recommended. Cuffless pants should be worn over boots or shoes to shed spilled liquid.

If clothing should become saturated with liquid Nitrogen or cold vapors, remove, if possible, to allow circulation to affected part of body.

July 1995

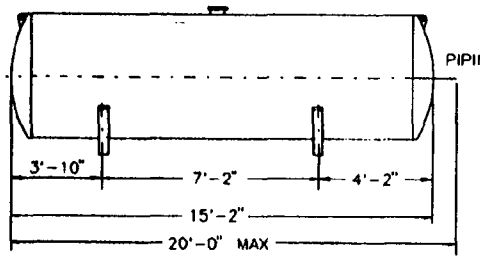
Issue Date

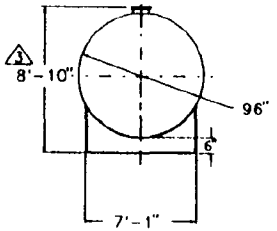
Process Engineering Inc.

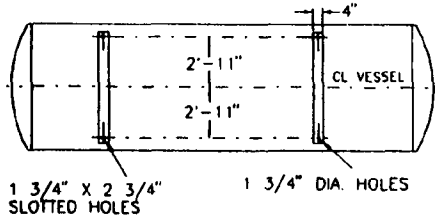


ITLM	FUNCTION	DESCRIPTION	SIZE	S/N
V-1	BOTTOM FILL VALVE	EXT STEM GLOBE, REGO BK9412S	1-1/2"	504.152
V-2	TOP FILL VALVE	EXT STEM GLOBE, REGO BK9412S	1-1/2"	504.152
V-3	PRESS BUILD VALVE	EXT STEM GLOBE, REGO BK9404S	1/2"	504.150
V-4	FULL TRYCOCK VALVE	EXT STEM GLOBE, REGO BK9404S	1/2"	504.150
V-5	TANK VACUUM GAGE VALVE	DIAPHRAGM, SUPERIOR, 216-10S	5/8"	519.302
V-6	TANK EVACUATION VALVE	DIAPHRAGM, CAST IRON, SAUNDERS	1-1/2"	584.125
V-7	CONTENTS GAGE BY-PASS	BRASS NEEDLE-NUPRO B-4JNA1	1/4"	519.080
V-8	CONTENTS GAGE SHUT-OFF	BRASS NEEDLE-NUPRO B-4JNA1	1/4"	519.080
V-9	CONTENTS GAGE SHUT-OFF	BRASS NEEDLE-NUPRO B-4JNA1	1/4"	519.080
V-10	VAPOR SHUT-OFF VLV	EXT STEM GLOBE, REGO BK9408S	1-1/2"	504.152
V-11	LIQUID WITHDRAWAL VLV	EXT STEM GLOBE, REGO BK9408S	1"	504.151
V-12	WITHDRAWAL LINE DRAIN	EXT STEM GLOBE, REGO BK9404S	1/2"	504.150
V-14	FILL LINE DRAIN VALVE	EXT STEM GLOBE, REGO BK9404S	1/2"	504.150
V-13	VAPOR VENT VALVE	EXT STEM GLOBE, REGO BK9412S	1-1/2"	504.152
CV-1	FILL LINE CHECK	SWING TYPE, POWELL, 7K-2825	1-1/2"	494.025
S-1	FILL LINE STRAINER	AF DWG. 8518507 REV A ASSEMBLY	2"	834.710
S-2	WITHDRAWAL LINE STRAINER	AF DWG. 8321391 REV A ASSEMBLY	1"	834.711
SV-1	INNER VESSEL SFTY	70 PSIG, SWENDEMAN HXSO	3/4"	834.712
SV-2	LINE SAFETY VLV (2)	100 PSIG REGO B9434N100	1/4"	559.100
SV-3	P.B. COIL SAFETY VALVE	100 PSIG SWENDEMAN AXSO	1/2" x 3/4"	834.713
SH-1	INNER VESSEL SFTY HD	105 PSIG OSECO OTU-8	1/2"	834.714
SH-2	JACKET SAFETY HEAD	DUAL O-RING	6"	-
PBC	PRESSURE BUILD COIL	ALUMINUM EXTRUSION	34 SQFT	-
LL	CONTENTS GAGE	6" BARTON 227A W/GAL SCALE O2/N2	0-100"WC	834.715
PI-1	TANK PRESS. GAGE	2-1/2", 0-100 PSI	-	834.718
TC	VAC. GAGE TUBE	HASTINGS DV-6R	-	574.060
C-1	FILL HOSE CONNECTOR	1-1/2"CGA, O2	-	876.014
C-1	FILL HOSE CONNECTOR	1-1/2"CGA, N2	-	876.016
C-2	LIQUID WITHDRAWAL CONN.	COUPLING, MALE HALF W/CAP, LOX	1"	834.719
C-2	LIQUID WITHDRAWAL CONN.	COUPLING, MALE HALF W/CAP, LN2	-	834.703
C-3	LIQUID OXYGEN HOSE CONN.	COUPLING, FEMALE HALF W/PLUG, LOX	1"	834.717
C-3	LIQUID N2 HOSE CONN.	COUPLING, FEMALE HALF W/PLUG, LN2	-	834.702
H-1	LIQUID WITHDRAWAL HOSE	10 FT LONG FLEXIBLE HOSE	1"	834.716

CS-11751 R3







INTERNAL LINE SIZES		
A	1.660"	BOTTOM FILL
B	1.660"	VENT
C	1.660"	TOP FILL (INT. SRAY HEADER)
D	.375"	BOTTOM GAGE
E	.375"	TOP GAGE
F	.375"	FULL TRYCOCK
G	1.660"	BOTTOM LIQUID DRAW

(DIM. ARE O.D.)

Vessel Design Data		
Inner Vessel:		H-3110-7-70
	MAWP:	70 PSIG
	Design Temperature:	-320F to +100F
	Hydrostatic Test Pressure:	175 PSIG
	Vessel Material:	SA-240 T-304 S/S
	Code Stamp:	YES
	Radiograph:	•RT-2
Outer Jacket:		
	MAWP:	Full Vacuum
	Design Temperature:	Ambient
	Sand Blasting:	Yes
	Painting:	Imron White
	Vessel Material	A36 Carbon Steel
	Insulation:	Evacuated Perlite
Weights:		
	Empty:	13,700 Lbs.
	Full of LN2	33,900 Lbs.
	Full of LO2	42,300 Lbs.
Capacity		
	Full of Water:	3116 Gallons
	At Trycock	3000 Gallons

Code ASME Section VIII Division 1 Latest Addenda
Inspected by National Board Inspectors with OH and PA Commissions
Piping ASME/ANSI B31.3
• Per UW-11(a)(5) Longitudinal Seams 100%
Girth Seams per Spot

NOTE:
TRANSFER HOSE PER PARAGRAPH 3.8 OF SPEC A-A-58000 IS INCLUDED.

NO	DATE	BY	CHKD	RECORD OF REVISION
3	6/3 1994	PMD		UPDATED TO ADD LN2 TANK INFO
2	7/13 1994	MLB		MOVED V-12 & SV-3 BEFORE S-2 IN PMD; CHG REPRESENTATION OF C-2, C-3 & H-1 IN PMD
1	6/4 1994	MLB		WAS EST No. 93138

PROCESS ENGINEERING INC.
146 Main Street, PO Box 467
Plaistow, NH 03865

CUSTOMER DRAWING FOR:

U.S. AIR FORCE, KELLY AFB

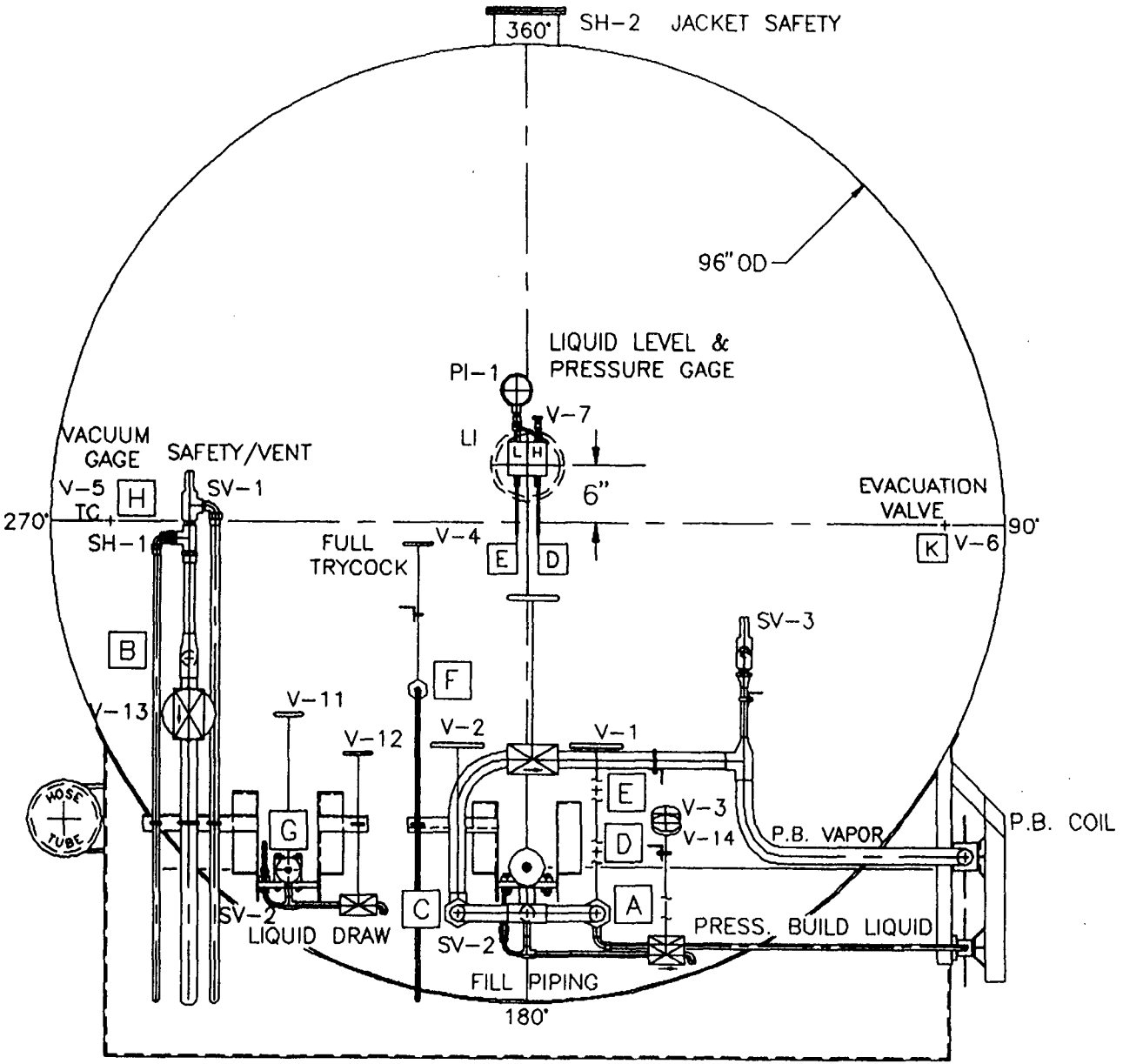
USAF NSN 3655-01-396-3099 (LN2)

USAF NSN No. 3655-01-391-9281YD (LO2)

MODEL H-3110-7-70 LO2/LN2 STORAGE TANK

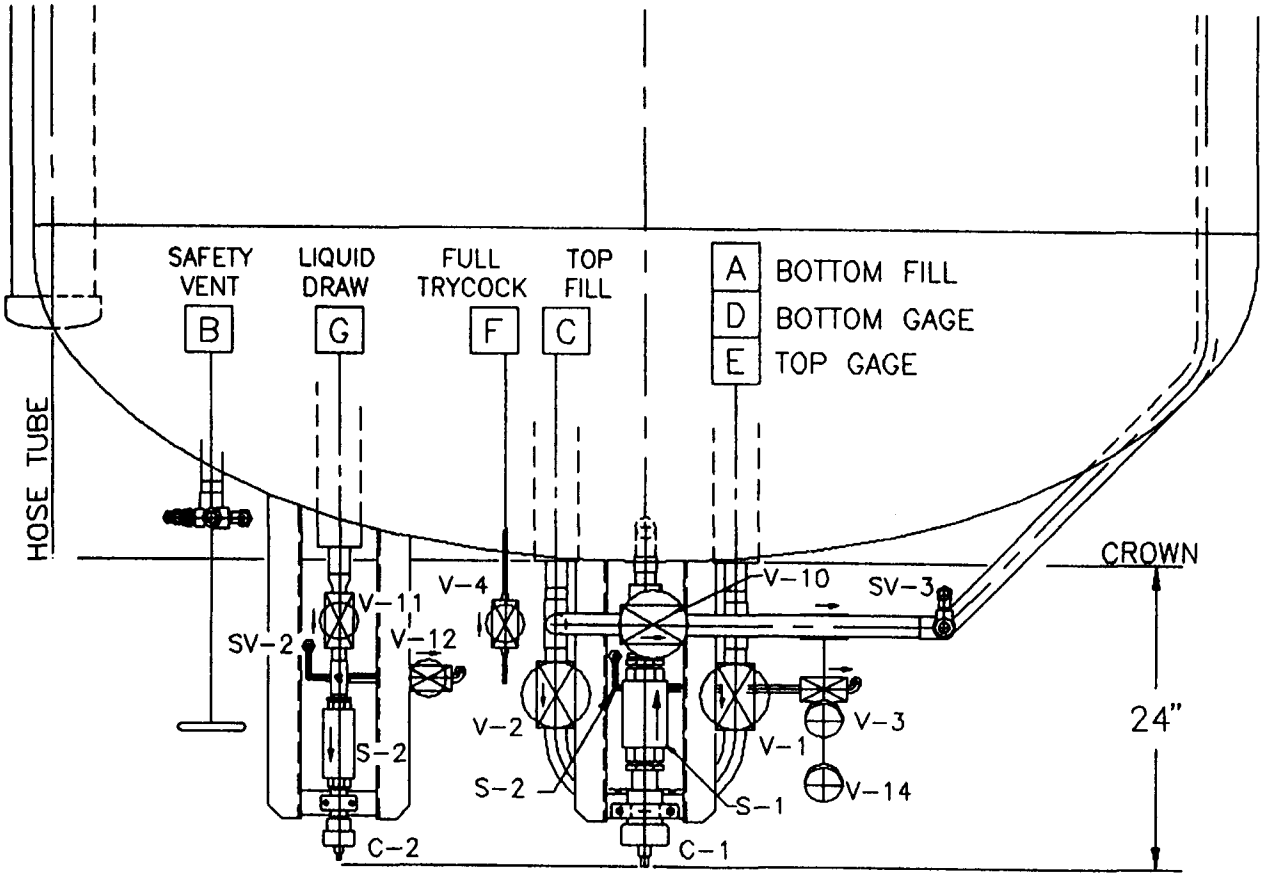
JOB No	N-06594 C-06594	F/C# D1/4	PART No.	834.700 834.905
APPROVALS	BY	DATE	SHEET 1 OF 1,	
DRAFTER	MLB	6/4 1993	CS-11751	3
CHECKER			DWG. NO.	REV.
ENGINEERING DESIGN				

Process Engineering



ELEV VIEW
KELLY A.F.B.
H-3110-7-70 LO2/LN2

FORM No. AC185A-R1



PLAN VIEW

KELLY A.F.B.
H-3110-7-70 LO2/LN2

FORM No. AC185B-R1

PROCESS ENGINEERING INC. · PLAISTOW, NH 03865

CONTENTS TABLE, MODEL H-3110-7-70

LIQUID OXYGEN at 50 PSIG Vapor Phase Tank Pressure

Liquid Density= 71.211 Lb/CuFt. Vapor Density= 1.102 Lb/CuFt. SCF/Lb= 12.076

GALLONS are at Liquid Density shown. TOTAL is Liquid + Vapor.

Inches H2O	GALLONS LIQUID	MSCF TOTAL
1.41	0	6
2	2	6
3	11	7
4	22	8
5	37	10
6	53	12
7	72	14
8	93	16
9	115	19
10	139	21
11	164	24
12	191	27
13	218	30
14	247	34
15	278	37
16	309	40
17	341	44
18	375	48
19	409	52
20	444	56
21	480	60
22	516	64
23	554	68
24	592	73
25	631	77
26	670	81
27	710	86
28	751	90
29	792	95
30	834	100
31	876	105
32	918	109
33	961	114
34	1004	119
35	1048	124
36	1092	129
37	1136	134
38	1181	139
39	1225	144
40	1270	149
41	1316	154
42	1361	160
43	1406	165
44	1452	170
45	1497	175
46	1543	180
47	1588	185
48	1634	190
49	1679	196
50	1724	201
51	1770	206

Inches H2O	GALLONS LIQUID	MSCF TOTAL
51	1770	206
52	1815	211
53	1860	216
54	1905	221
55	1949	226
56	1994	231
57	2038	236
58	2081	241
59	2125	246
60	2168	251
61	2210	256
62	2253	260
63	2294	265
64	2336	270
65	2376	274
66	2417	279
67	2456	284
68	2495	288
69	2534	292
70	2571	297
71	2608	301
72	2644	305
73	2679	309
74	2714	313
75	2747	316
76	2780	320
77	2812	324
78	2842	327
79	2872	331
80	2900	334
81	2927	337
82	2952	340
83	2977	342
83.96	2998	345

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CONTENTS TABLE, MODEL H-3110-7-70 LN2
LIQUID NITROGEN at 50 PSIG

Liquid Density= 45.694 Lb/CuFt. Vapor Density= 1.153 Lb/CuFt. SCF/Lb= 13.803
GALLONS are at Liquid Density shown. TOTAL is Liquid + Vapor.

Inches H20	GALLONS LIQUID	MSCF TOTAL	Inches H20	GALLONS LIQUID	MSCF TOTAL	Inches H20	GALLONS LIQUID	MSCF TOTAL
1.47	0	7	26	1270	111	51	2876	243
1.5	0	7	26.5	1305	114	51.5	2898	245
2	4	7	27	1341	117	52	2919	246
2.5	11	7	27.5	1376	120	52.5	2939	248
3	20	8	28	1412	123	53	2958	250
3.5	31	9	28.5	1448	126	53.5	2977	251
4	43	10	29	1483	128	53.83	2989	252
4.5	57	11	29.5	1519	131			
5	71	12	30	1555	134			
5.5	87	14	30.5	1591	137			
6	104	15	31	1626	140			
6.5	122	17	31.5	1662	143			
7	141	18	32	1698	146			
7.5	161	20	32.5	1733	149			
8	182	22	33	1769	152			
8.5	203	23	33.5	1804	155			
9	226	25	34	1840	158			
9.5	249	27	34.5	1875	161			
10	272	29	35	1910	164			
10.5	297	31	35.5	1945	166			
11	322	33	36	1980	169			
11.5	347	35	36.5	2015	172			
12	374	37	37	2049	175			
12.5	400	39	37.5	2083	178			
13	428	42	38	2117	181			
13.5	456	44	38.5	2151	183			
14	484	46	39	2185	186			
14.5	513	49	39.5	2218	189			
15	542	51	40	2251	192			
15.5	572	54	40.5	2284	194			
16	602	56	41	2317	197			
16.5	633	59	41.5	2349	200			
17	664	61	42	2381	202			
17.5	695	64	42.5	2412	205			
18	727	66	43	2443	207			
18.5	759	69	43.5	2474	210			
19	791	72	44	2504	212			
19.5	824	74	44.5	2534	215			
20	857	77	45	2564	217			
20.5	890	80	45.5	2593	220			
21	923	82	46	2621	222			
21.5	957	85	46.5	2649	224			
22	991	88	47	2677	227			
22.5	1025	91	47.5	2704	229			
23	1060	94	48	2730	231			
23.5	1094	97	48.5	2756	233			
24	1129	99	49	2782	235			
24.5	1164	102	49.5	2806	237			
25	1199	105	50	2830	239			
25.5	1234	108	50.5	2853	241			
26	1270	111	51	2876	243			

08-03-1995

PARTS LIST

TAG	FUNCTION	DESCRIPTION	P/N
SAFETY/VENT			
SV-1	INNER VESSEL SAFETY VALVE	3/4" SWENDEMAN RXS0, 70 PSIG	834712
SH-1	INNER VESSEL SAFETY HEAD	1/2" OSECO OTU-6, 105 PSIG	834714
-	-	3/4" MPT X 1/2" FPT BUSHING	361320
-	-	1/2" X 1/2" UNION ELBOW	330460
-	-	3/4" X 3/4" UNION ELBOW	330469
LIQUID DRAW			
V-11	LIQUID WITHDRAWAL	1" EXT. STEM GLOBE, REGO	504151
V-12	WITHDRAWAL LINE DRAIN	1/2" EXT. STEM GLOBE, REGO	504150
S-2	WITHDRAWAL STRAINER	1" AF DWG 8321391 REVA	834711
C-2	LIQUID CONNECTION	LOX MALE HALF W/CAP	834719
C-2	LIQUID CONNECTION	LN_2 MALE HALF W/CAP	834703
SV-2	LINE SAFETY VALVE	100 PSIG REGO B9434N100	559100
FULL TRYCOCK			
V-4	FULL TRYCOCK VALVE	1/2" EXT. STEM GLOBE, REGO	504150
-	-	EXTENDED BUSHING 1/2" X 1/4"	314102
FILL PIPING			
V-1	BOTTOM FILL VALVE	1 1/2" EXT. STEM GLOBE, REGO	504152
V-2	TOP FILL VALVE	1 1/2" EXT. STEM GLOBE, REGO	504152
V-14	FILL LINE DRAIN VALVE	1/2" EXT. STEM GLOBE, REGO	504150
SV-2	LINE SAFETY	100 PSIG REGO B9434 N100	559100
S-1	FILL LINE STRAINER	2" AF DWG 8518507 REV A	834710
C-1	FILL HOSE CONNECTOR	1 1/2" CGA FOR O2	376014
CV-1	FILL CHECK VALVE	1 1/2" SWING CHECK	494025
-	-	HEX BUSHING 2" MPT X 1 1/2" FPT	361555
-	-	NIPPLE TBE 1 1/2" X 3" LONG	434178
C-1	FILL HOSE CONNECTOR	1 1/2" CGA FOR N_2	376016

JULY 1994

Issue Date

PARTS LIST (CONT.)

PRESSURE BUILD LIQUID

V-3	PRESSURE BUILD VALVE	1/2" EXT. STEM GLOBE, REGO	504150
PBC	PRESSURE BUILD COIL	ALUMINUM EXTRUSION	834735
-	-	MALE CONNECTOR 1" ODT X 1" MPT	402592
-	-	MALE CONNECTOR 1" ODT X 1/2" MPT	402587

PRESSURE BUILD VAPOR

V-10	VAPOR SHUT-OFF VALVE	1 1/2" EXT. STEM GLOBE, REGO	504152
SV-3	P.B. COIL SAFETY VALVE	1/2" X 3/4" SWENDEMAN RX50, 100 PSIG	834713
-	-	3/4" UNION ELBOW	330469

LIQUID LEVEL/PRESSURE GAGE

LI	CONTENTS GAGE	BARTON 227A O2/N2 SCALE	834715
PI-1	TANK PRESSURE GAGE	2 1/2", 0-100 PSI	834718
V-7	CONTENTS GAGE BY-PASS	1/4" BRASS NEEDLE VALVE	519080
V-8	CONTENTS GAGE SHUTOFF	1/4" BRASS NEEDLE VALVE	519080
V-9	CONTENTS GAGE SHUTOFF	1/4" BRASS NEEDLE VALVE	519080
		MALE CONNECTOR 1/4" ODT X MPT	403549
		ADAPTER, 1/4" ODT	402045
		TEE, FEMALE RUN 1/4"	402927

VACUUM GAGE

V-5	VACUUM GAGE VALVE	5/8" SUPERIOR 216-10S	519302
TC	VACUUM GAGE TUBE	HASTINGS DV-64	574060

EVACUATION VALVE

V-6	TANK EVACUATION VALVE	1 1/2" SAUNDERS	584125

JACKET SAFETY

SH-2	JACKET SAFETY HEAD	SAFETY HEAD COVER PLATE	564607
		6 1/4" ID X 1/4" O-RING	745024
		7 1/4" ID X 1/4" O-RING	745040

PARTS LIST (CONT.)

MISCELLANEOUS

H-1	LIQUID WITHDRAWAL HOSE	10' LONG FLEXIBLE HOSE	834716
C-3	LIQUID 02 HOSE CONN.	COUPLING FEMALE W/PLUG	834717
C-3	LIQUID N_2 HOSE CONN.	COUPLING FEMALE W/PLUG	834702
-	HOSE TUBE	6" PVC X 12' LONG	834998
-	HOSE TUBE COVER	6" PVC CAP	834972
-	HOSE TUBE PIN	1/2" QUICK RELEASE PIN	612648

GLOBE VALVE PARTS

-	SEAT/PLUG FOR 1/2" GLOBE	BK8400-80AJ	509550
	PACKING ASS'Y FOR 1/2" GLOBE	BK8400-80J	509650
	SEAT/PLUG FOR 1" GLOBE	BK8400-80BJ	509551
	PACKING ASS'Y FOR 1" GLOBE	BK8400-80J	509651
	SEAT/PLUG FOR 1 1/2" GLOBE	BK9400-80AJ	509552
	PACKING ASS'Y FOR 1 1/2" GLOBE	BK9400-80J	509652
	PLUG ASS'Y 1 1/2"	KELF DISC/BRASS HOLDER	509510

SPECIAL EQUIPMENT

TC	VACUUM GAGE TUBE	HASTINGS DV-6R	574060
-	PORTABLE VACUUM GAGE	HASTINGS TV-47 OR TV-4A	***

***AVAILABLE FROM:
TELEDYNE, HASTINGS-RAYDIST
HAMPTON, VIRGINIA 23661
804-723-6531

HORIZONTAL 7B MODELS

SECTION II - DESCRIPTION

Definition

A "Storage Tank," is a system designed primarily to receive and store an industrial gas in liquid form and to deliver it in liquid form.

For simplicity, the storage tank is operated at a sufficiently high pressure to provide flow of liquid at the desired flow rate.

Basic Components

A Storage Tank is made up of a tank, piping, safety devices and gages.

Tank

Most tanks for the commoner cryogenic liquids, with capacities between 100 gallons and 50,000 gallons, are similar in principle. An "inner vessel" or "liquid container" is supported within an "outer vessel" or "vacuum jacket" with the space between filled with Perlite powder and evacuated. Necessary piping connects from inside of the inner vessel to outside of the vacuum jacket. Gages and valves to indicate and control the product in the vessel are mounted outside of the vacuum jacket. Legs or saddles to support the whole assembly are welded to the outside of the vacuum jacket. Figure 1 illustrates these components.

Inner Vessel (1)

Inner vessels are designed, fabricated, tested and stamped in accordance with the ASME Code for Unfired Pressure Vessels. Material must have good ductility at cryogenic temperatures. Austenitic stainless steels, most aluminum alloys and 9% Nickel steel must meet this requirement. The tanks covered by this Manual have SA240 T304SS inner vessels and are designed for a maximum working pressure of 70 psi.

Jacket (2)

Outer vessels, intended only for vacuum, are not Code designed or stamped. Since they do not operate at cryogenic temperatures, they are made of mild steel. Stainless steel stand-offs are used where cold piping penetrates the outer vessel, to protect the mild steel from being excessively chilled.

Inner Vessel Supports (3)

The main supports (3A) for the inner vessel, are made from austenitic stainless steel because it has lower thermal conductivity than most metals, combined with good strength, excellent low temperature ductility and ready availability. Plastic laminate is used for centering bumpers (3B) because of its low conductivity.

Insulation (4)

Insulation is Perlite - a natural mineral which has been crushed and then expanded by heating - because it combines to a remarkable degree the virtues of good insulating value, inertness and low cost.

Internal Piping (5)

The Customer Drawing enclosed, Drawing CS-11751 in Section I shows schematically the number of lines between inner vessel and jacket.

This piping is austenitic stainless steel, again because of its low conductivity, strength, ductility and availability. Piping connected to the liquid phase (bottom) of an inner vessel is "trapped" - bent in some manner that produced the effect, if not the appearance, of a sink trap - near the inner vessel. With a properly trapped line and a closed valve outside, most of the pipe is full of vapor and heat flow to the stored liquid is minimized. (If a line were not trapped, liquid would stand - or try to stand -against the closed valve outside the jacket, and, heat flow to the liquid would be drastically increased).

Jacket Supports (6)

PEI standard horizontal Storage Tanks are supported on saddles or legs welded to the jacket. Refer to the Customer Drawing enclosed, Drawing CS-11751 in Section I, for details on type, size and location of supports.

External Piping

For discussion, the piping shown schematically in the Customer Drawing is comprised of several sub-systems.

For handling the atmospheric gases, materials of external piping are Type K Copper tube, wrought Copper fittings and bronze-bodied valves, assembled principally by silver soldering.

Filling System

This sub-system consists of a "Bottom Fill" valve (V-1), a "Top Fill" valve (V-2), a "Fill Check" valve (CV-1), a "Hose Drain" valve (V-14), a "Hose Safety" valve (SV-2), a Bottom Fill line [A] and a Top Fill line [C].

The Top Fill line terminates with a spray header inside the top of the inner vessel.

Bottom filling causes tank pressure to increase, as would be expected, because it reduces the space available for vapor. Top filling causes tank pressure to decrease. This is because when a tank is at an elevated pressure, the vapor is relatively warm and the liquid being added is (usually, at least) relatively cold. Spraying cold liquid into the vapor in the tank cools the vapor and condenses part of it, thus reducing the pressure in the vapor space. By carefully dividing the filling flow between the "Top Fill" and "Bottom Fill" valves, it is possible to maintain pressure nearly constant during filling.

The "Hose Safety" valve is necessary to prevent excessive pressure buildup in the transfer hose at the termination of a fill, if both ends are valved off with liquid in the hose. The "Hose Drain" valve is used to release pressure from the hose before disconnecting, as well as for purging the hose prior to filling.

A CGA standard fill hose connector (C-1) and a fill line strainer (S-1) have been included. The CGA connector for Oxygen and Nitrogen are different and are not interchangeable. The proper connector must be used.

Pressure Build System

A pressure build system is needed in many situations to keep tank pressure high enough to provide the desired flow of product. The principle of the pressure build system is simple. Liquid product is allowed to flow by gravity from the bottom of the inner vessel to a heater outside of the vacuum jacket, and, vaporized product is allowed to flow back to the top of the inner vessel. An increasing amount of vapor trying to squeeze into an almost constant space makes the pressure rise.

The major components to make this work are a heater and a means of control.

The heater is an assembly of aluminum fin tubes exposed to the atmosphere (to a product at -300 degrees, even an arctic atmosphere seems warm).

The control is a manual globe valve, whereby all materials are selected and the valve is cleaned for low temperature Oxygen service. The "Pressure Build" valve (V-3) is normally closed and "Vapor Shut-off" valve (V-10) is normally open. Opening of the pressure build valve will result in an increase in the tank pressure. Once the desired tank pressure is attained for proper liquid flow, the valve can be shut. The valve can also be throttled to maintain the tank pressure during extended periods of liquid withdrawal.

On standard converters this sub-system consists of a "Pressure Build" manual valve (V-3), a "Pressure Build Coil" (PBC), "Line Safeties" (SV-3), and a "Vapor Shut-off" valve (V-10), and is connected between the Bottom Fill line [A] and the Top Fill line [C].

Product Delivery

This sub-system consists of a "Liquid Withdrawal" valve (V-11), a "Withdrawal Line Drain" valve (V-12), a "Line Safety" valve (SV-2), a "Withdrawal Line Strainer" (S-2) and a "Liquid Withdrawal Hose" (H-1). The liquid withdrawal hose terminates with a "Liquid Oxygen or Nitrogen Hose Connector" (C-3). During tank transportation, and when "NOT-IN-USE", the flexible hose (H-1) can be disconnected and stored in the special hose storage tube provided on the side of the tank supported between the saddles.

Liquid Transfer from the Storage Tank

Prepare the service cart or other receiving vessel to be serviced by the storage tank in accordance with its applicable Technical Manual.

A. Check the position of all control and gaging valves of the storage tank. The vapor vent shutoff valve (V-10), the fill/drain shutoff valve (V-1) V-2), the service line shutoff valve (V-11), service line drain valve (V-12), fill/drain valve (V-14), fill trycock valve (V-4), and the pressure buildup valve (V-3) must be closed.

B. Check the quantity of product in the storage tank on the liquid level gage (LL). Make sure that sufficient product is available to complete the scheduled transfer.

C. Remove the service line hose from within the storage tube.

D. Slowly open the pressure buildup valve to raise the tank pressure (50 psig maximum). Monitor the tank pressure gage (PI-1) as the pressure increases. Close the pressure buildup valve (V-3) in sufficient time to prevent the pressure from rising above 50 psig. Relieve pressure by opening the vapor vent shutoff valve (V-10). Do not allow pressure to exceed 50 psig.

   1. If the receiving vessel is at ambient temperature, it should be chilled before filling.

   2. Follow the applicable directives for the vessel being filled.

NOTE

Pressure may increase very rapidly. Pressure buildup is influenced by the vapor space above the liquid in the tank. Pressure will increase after the PBU valve (V-3) is closed until all liquid in the buildup coil has been vaporized.

E. Remove hose cap. Supporting the service hose with heavily gloved hands, slightly open service valve (V-11), and allow a very small amount of product to pass through the hose, purging it of air. Close service valve.

F. Remove the dust cap from the receiving vessel fill line coupling.

G. Attached the hose to the receiving vessel coupling.

H. Open the fill valve of the receiving vessel.

I. Open the service valve (V-11) slowly. Watch the escaping vapors at the vapor vent of the receiving tank. As the rapid boiling of the product entering the tank diminishes, open the valve fully.

J. Fill the receiving vessel to the desired level.

1. Use extreme caution when disconnecting a service hose.

2. Do not point it at personnel. Do not allow product to touch bare skin.

K. Close the storage tank service valve (V-11) and the fill valve of the receiving tank. Immediately relieve the pressure from the hose by manually opening the service line drain valve (V-12). If the receiving tank does not have a drain valve, slowly and carefully uncouple the service hose coupling from the receiving tank.

L. Loosely reinstall the dust cap on the receiving tank fill coupling.

M. If more than one receiving tank is to be filled, retain pressure in the storage tank until all transfers have been made. Close service line drain valve (V-12) and repeat steps A. through M. for each vessel to be filled.

N. When all liquid transfers have been accomplished, open vapor vent shutoff valve (V-10) to relieve pressure in the storage tank and allow the vapor shutoff valve (V-10) to remain open.

O. When the service hose has been drained, put hose cap on and return it to the storage tube.

Safety Devices

The tank safety valve (SV-1), to prevent excessive pressure buildup in the inner vessel, is a standard ASME safety relief valve, except that materials are selected, and the valve is cleaned for oxygen service. The valve is softseated to minimize leakage below the set point. The tank safety valve is set at the maximum allowable working pressure of the inner vessel, and is sized by CGA rules to relieve the boil-off expected if the tank were exposed to a fire.

The inner vessel is also protected by a rupture disc with a room temperature rated rupture pressure 50% above the safety valve setting. This rating is necessary to avoid premature creep failure of the disc, and is still slightly below the inner vessel test pressure. Most tanks have "throw-away" rupture disc units; if the disc ruptures, the whole unit is unscrewed and discarded.

Jacket safety heads (SH-2) are intended to relieve any positive pressure, which might result from a leak in an inner vessel, from the jacket. PEI's standard jacket safety is a flanged stainless steel nozzle with two concentric O-rings, covered by a machined stainless plate. Being held closed only by atmospheric pressure external, this will relieve at extremely low positive jacket pressure.

Gages

The standard method of measuring contents is by means of a differential pressure instrument connected to the top and bottom of the tank and reacting to the pressure difference caused by the weight of the liquid. A contents table, showing quantity of contents as a function of gauge reading, is furnished, see Section I.

These instruments are not directly affected by the total pressure in the tank, but the product density does change with total pressure. Because of the density change, contents tables in gallons vary considerably with pressure, and because the average density is not directly related to the tank pressure, it is very difficult to select the correct table to use. However, the number of pounds, or of equivalent standard cubic feet, of product represented by any given gauge reading changes very little with product density and pressure.

Standard customer stations have 6-inch dial differential pressure indicator as shown on the customer drawing.

These instruments are connected with three valves - a liquid side shut-off (V-8), a gas side shut-off (V-9), and a by-pass (V-7). The by-pass connects to the liquid side and to the gas side between the instrument and the shut-off valves. The by-pass is used for checking the instrument. By closing both shut-offs and opening the bypass, the pressure is made the same on both sides of the instrument and a properly operating instrument will read "0" inches of water, regardless of the tank pressure.

If the two shut-offs and the by-pass are all left open at the same time, the instrument lines become a small build-up circuit and causes a slow rise in tank pressure. At least one of these three valves should always be closed.

The tank pressure gauge, to indicate pressure inside the inner vessel, is a standard Bourdon tube pressure gauge which has been cleaned for oxygen service and is connected to the gas side of the contents indicator.

The standard vacuum gaging equipment is a thermocouple vacuum gauge tube. Tank is furnished with a Hastings DV-6R tube. To read the vacuum a compatible Hastings gage must be used.

For the level of vacuum used in converter installation, the common unit of pressure is (or was) "microns of mercury absolute," usually abbreviated to "microns." (It is pointless to measure such pressures down from atmospheric -- the atmosphere changes thousands of microns from day to day). In recent years the units "Torr" and "Millitorr" have come into use for vacuum measurement. A "Torr" is a pressure of one millimeter of mercury absolute. A Millitorr is 1/1000 Torr.

The "Full Trycock" is simply a line which ends inside the inner vessel at the highest level to which the vessel is intended to be filled, and has a valve (V-4) outside the outer vessel. If this valve is opened during the later stages of filling, it will emit vapor (very cold vapor) until the liquid level reaches the open end of the line, when it will start to emit liquid. The change from vapor emission to liquid emission is both visible and audible.

Tank Management

This tank is classified as FSC 3655 registered Air Force ground support equipment. It is to be managed under provisions of AFR 66-1. Using activities will record the USAF registration number located on the tanks data plate. The USAF registration number consists of a 13 digit alpha-numerical arrangement which indicates: (1) The Federal Supply Class, (2) Calendar year in which the tank was built, (3) Federal Item Identification Number (FIN), and (4) Assigned serial number. When the serial number consists of fewer than four digits, zeros will be added in front of the serial number. Example: PEI manufactured tanks, A-A-58000, Type I, Size A, Part Number CS-11751, NSN 3655-01-391-9281 and delivered in 1994 with serial number beginning with 0001. The Federal Item Identification Numbers assigned to tanks is EAU" for LOX. The sample registration number, therefore, would be "3655-94-EAU-0001". PEI manufactured tanks, A-A-58000 Type II, Size A, Part Number H-3110-7-70LN2, NSN 3655-01-396-3099 and delivered in 1995 with serial number beginning with 0001. The Federal Item Identification Numbers assigned to tanks is (EAW) for LIN. The sample registration number, therefore, would be "3655-95-EAW-0001).

Compliance with the afore stated instructions shall be reported in accordance with AFM 66-1 and T.O. 00-25-215.

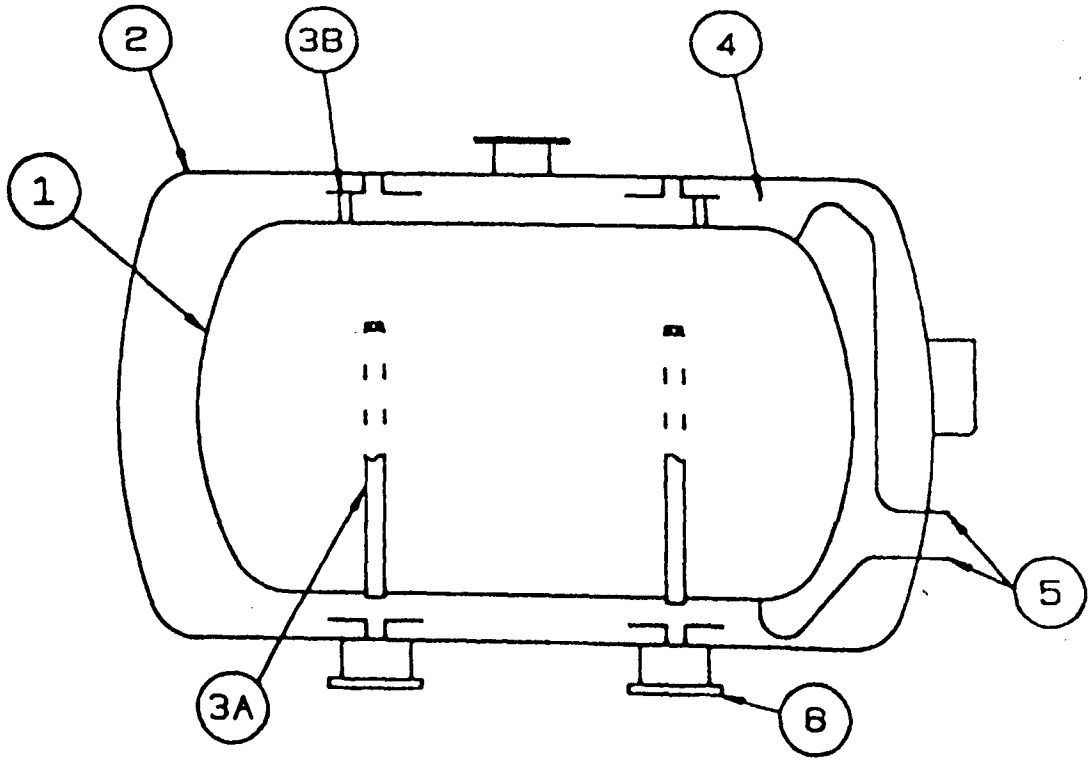


FIGURE 1
TYPICAL CONVERTER VESSEL

SECTION III - INSTALLATION

Preliminary Inspection

Newly-received vessels should be immediately inspected for shipping damage.

Check the insulation space pressure with a "Hastings" thermocouple vacuum gauge. Other manufacturers gages are NOT compatible with the Hastings DV-6R tube on this tank. While this is not precise, it will, at least, indicate a major loss of vacuum. Make note of the ambient temperature when the vacuum is read. Temperature changes affect the vacuum reading in an empty vessel.

Check for gas pressure in the inner vessel. Vessels are shipped with 10 to 20 psig Nitrogen pressure. If the pressure is in this region on arrival, the piping must be free from leaks.

Erection

All vessels are shipped horizontally.

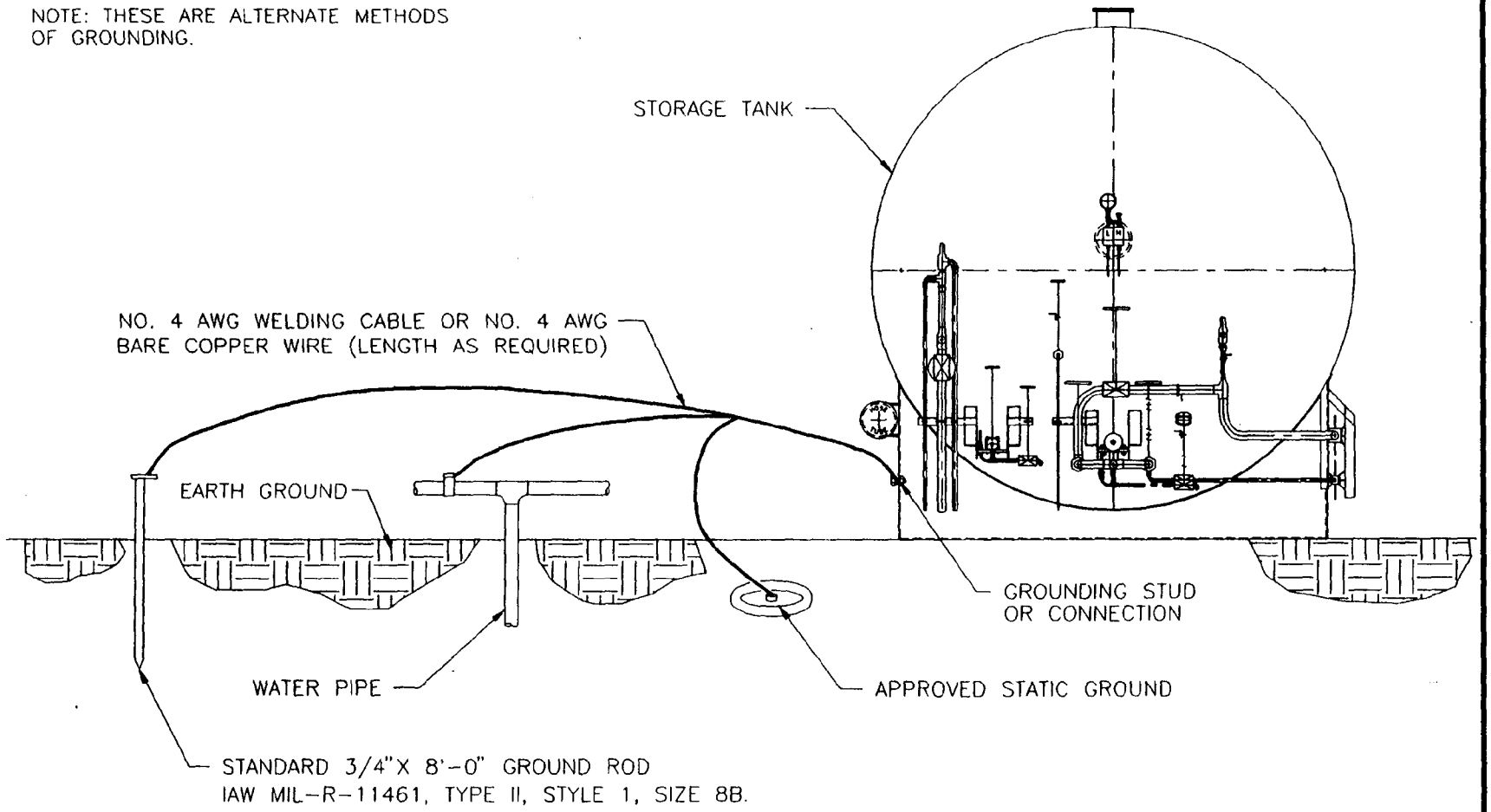
Horizontal vessels are simply lifted off the delivery vehicle and set in place using the lifting lugs located at the top center of each head. This tank is not designed to be lifted with a fork lift from the bottom.

Horizontal tanks can be installed on concrete slabs, concrete piers, or on structural steel.

Care should be used in attaching slings and/or cables and in lifting to avoid unnecessary damage to paint and to the gages.

NOTE: DO NOT DRAG TANK ON ITS LEGS.

NOTE: THESE ARE ALTERNATE METHODS OF GROUNDING.



STATIC GROUNDING

GROUNDING REQUIREMENTS. PRIOR TO DESIGNATED OPERATIONS, THE TANK SHALL BE GROUNDED AGAINST THE EFFECTS OF STATIC ELECTRICITY REFERENCE T.O. 00-25-172.

Storage

If tank is to be stored for a considerable period:

1. Protect it from vandals and "valve twiddlers";
2. Maintain a positive pressure of Nitrogen in the inner vessel;
3. Keep openings sealed against rain, dirt and insects; and
4. Monitor jacket vacuum.

Connections

This tank will require a connection from the "Liquid Draw" line to the intended usage container. The connection will be made to C-3 through the flexible hose provided.

Make sure all materials, cleaning and joining procedures are suitable for the service. Be sure to install a safety valve in any section of piping where liquid or very cold vapor could be trapped between shut-off or regulating valves, and in the customer's line.

Test all joints.

Purging

If the vessel arrived with a positive pressure of nitrogen it is NOT necessary to purge the vessel with hot dry air. If the tank is to be used for nitrogen proceed with initial fill.

If the tank will be used for oxygen it is a good practice to exchange the nitrogen atmosphere with an oxygen atmosphere. This can be done during initial fill by circulating oxygen gas from oxygen trailer before allowing liquid into the tank.

The major point is that no liquid should be allowed in the vessel until the gaseous contents are of the desired purity. Once contaminated liquid is in the vessel, it will be a slow and costly operation to get it out completely.

It is good practice to blow out all lines - particularly gauge lines - during the cool-down phase of the initial fill, as follows.

Purging, if required, shall be in accordance with the following:

Purpose. Purging is the process of forcing heated air through the drained tank. Purging causes residual LOX and contaminants to be converted to a gaseous state and be expelled from the tank. Contaminants such as moisture and carbon dioxide may be present in a solidified state along with the product at cold temperatures. These contaminants tend to settle within the tank sump. Their concentration increases with tank usage. Laboratory or order test determine when contaminants have reached an undesirable level requiring draining and purging the tank.

Frequency. LOX tanks shall be drained and purged whenever impurities exceed the use limits or on an annual basis (reference last purge date). These limits are established in T.O. 43B6-1-1 or T.O. 42B7-3-1-1. These T.O.s specify that whenever contamination is suspected, a sample of the product shall be sent to a designated laboratory for testing. Liquid Oxygen/Nitrogen Sample Model FSC2001 or equivalent is required for this purpose. Analysis of the results of the test shall be used by the Base Fuels Officer to determine if purging is required. When contamination is authenticated the source tank shall be purged. This ensures complete disposal of contaminants.

NOTE

All necessary repairs needed on the tank should be accomplished when empty. Certain repairs require purging before and after the repairs are accomplished. Annular space evacuation (vacuum pumpout) should be accomplished during the purging process. If it is not feasible to purge and pump at the same time, the vacuum pumping should be accomplished after the purge, while the inner tank is still hot.

Procedures. Purging procedures shall be accomplished according to the following:

A. Ensure that the tank does not contain product.

B. Remove filters and open level indicator isolation valves (V-8 and V-9), equalizer valve (V-7), and disconnect line tubes to the liquid level indicator (LL).

NOTE

The GSU-62/M Purging Unit or equivalent is required to purge LOX tanks.

C. Position GSU-62/M purging unit next to the tank vent line. Connect the purging unit to a source of 220/440-volt, 3 phase, 60 cycle AC power outlet.

D. Connect the appropriate purging unit adapter to the tank vent line.

E. Connect the purging unit discharge hose to the tank vent line. Attach the temperature gauge to the fill/drain line outlet.

F. Fully open the vent valve and the fill/drain line shutoff valve.

CAUTION

Do not allow the temperature of the air exiting the tank to exceed 220°F to prevent possible damage to the tank.

G. Start and operate the purging unit following instructions given in T.O. 36G2-3-1. Operate the purging unit and monitor the temperature gauge at the FDL outlet until the gauge indicates 220°F. This temperature can be maintained by cycling the purging unit heater switch OFF and ON as necessary.

WARNING

All piping and valves on the tank will become HOT. Contact with the piping or valve will result in burns.

H. Alternately open and close all the valves to ensure that hot air flows through the piping and valves.

I. Continue to purge with the fill/drain line outlet temperature at 220°F for three (3) hours.

J. When the purging time has expired, turn off the purging unit heater switch. Continue air flow into the inner shall until the fill/drain line outlet temperature has cooled to 150°F. This will prevent cooling gases from later causing a vacuum to occur in the inner shell and drawing atmospheric air and moisture into the inner shell if a valve is opened.

K. Close all valves. Turn off and disconnect the purging unit and adapters from the tank. Reposition the purging unit away from the area.

L. Install clean filters.

NOTE

The 220°F tank outlet temperature is the preferred temperature at which the tank should be purged. However, if conditions do not permit attainment of that temperature the technician will reach the highest temperature possible and then continue purging for that period of time as stated in Table II.

M. Operate purging unit at the maximum attainable temperature at the fill/drain line outlet for the time specified in Table I.

TABLE I

MAXIMUM TEMPERATURE ATTAINED (F°)	PURGING TIME (HOURS)
220	3
210	4
200	6
190	9
180	12
170	18
160	29
150	36
140	48

N. Reconnect all tubing to instruments.

CAUTION

To minimize thermal shock to the inner tank after purging a 24 hour waiting period should be initiated to allow the inner tank to cool before service. This waiting period will be adhered to if operational requirement permits. Upon initial servicing of the tank regardless of whether the tank was allowed to cool or not, the servicing pressure should not exceed 10 psig. This action will help lengthen the service of the inner tank.

O. Service the tank according to initial fill procedures.

Initial Fill

1. Connect hose to transport and remove cap from tank end of hose.
2. See that transport has some pressure and open appropriate transport valves for a few seconds to blow some product gas through the hose to remove any foreign matter that might be in it.
3. Connect hose to Converter.
4. Again, open transport valves to pressurize the hose and check for leaks.
5. Disconnect gauge lines from contents gauge and open line shut-off valves.
6. Open Top Fill valve and Vent valve.
7. Start transferring liquid at a low rate by pressure difference only.
8. As vapor flows freely from both gauge lines, close valves and reconnect contents gauge.
9. Be sure contents gauge by-pass valve and Pressure Build manual valve are closed.

10. Watch tank gages. If contents gauge oscillates violently, partially close liquid valve and gas valve. If necessary, close liquid valve and open by-pass valve to shut off gauge.

11. If contents gauge has been shut off, periodically try it to see if it can sensibly be left in operation and to get an idea of the liquid level.

12. When the tank is approximately 1/4 full, try closing Vent valve and opening bottom fill valve and closing top fill valve.

13. When tank pressure gets high enough -- say about 10 psi above desired operating pressure -- open Top Fill valve and close Bottom Fill valve.

14. If pressure rises too high with Top Fill open and Bottom Fill closed, open Vent enough to hold desired pressure.

15. When tank is approximately 3/4 full, open Full Trycock.

16. When liquid flows out of Full Trycock, stop pump and close Top Fill, Bottom Fill, Vent and Full Trycock valves.

17. Close transport valves and drain hose. (Even though hose pressure has been released, be careful when hose is disconnected -- sometimes liquid stays in hose for an amazingly long time).

18. Watch tank pressure -- it will tend to rise quite rapidly in a vessel which has just been filled for the first time.

19. Be sure the gauge shut-off valves are open and the contents gauge by-pass is closed.

SECTION IV - Operation

REFILLING PROCEDURE

1. Connect hose, purge hose, and check for leaks as under "Initial Fill."
2. Start filling through Bottom Fill valve, using transfer pump on transport.
3. Watch tank pressure. When it starts to rise, start opening "Top Fill" and closing "Bottom Fill" until pressure is steady at desired tank operating pressure.
4. Increase pumping speed if so desired.
5. Open both "Top Fill" and "Bottom Fill" valves gradually until one is wide open and pressure is steady.
6. Watch contents gauge -- when it shows about 90% full, open "Full Trycock" valve.
7. When liquid comes out of the "Full Trycock," stop pumping. Close "Bottom Fill," "Top Fill," and "Full Trycock" valves. Close appropriate valves on transport and bleed pressure from hose.
8. Disconnect hose and cap connections.

OPERATING PROCEDURE

Refer to Pressure Build System and Product Delivery in Section II.

SECTION V - TROUBLE SHOOTING

PROBLEM	POSSIBLE	ACTION
INNER VESSEL SAFETY VALVE POPS	Excessive tank pressure	Check tank pressure (see below)
	Faulty safety valve	Replace
INNER VESSEL RUPTURE DISC BLOWS	Faulty or corroded disc	Examine and replace
	Excessive tank pressure plus faulty safety	Check tank pressure Check safety valve See Paragraph 2*
EXCESSIVE TANK PRESSURE	Pressure build valve left open	Closing valve
	No product withdrawal	Open appropriate valves
	Inadequate vacuum	See Maintenance
	Tank pressure gauge reading wrong	Recalibrate or replace
BAD VACUUM READING (Reading must be taken with compatible vacuum gage)	Tube shut-off closed leak at joint	See Paragraph 2*
	Bad tube	Replace See Paragraph 3*
	Vacuum valve not closed tight, or leaking	See Paragraph 4*
	Leak between vacuum valve and vessel	See Paragraph 5*
	Jacket safety head	Replace
	O-rings leaking	See Maintenance
TANK PRESSURE TOO LOW	Pressure build manual valve closed	Open valve
	Tank pressure gauge reading wrong	See below

*Numbered Paragraphs referred to above can be found on the pages following this outline.

1. If a rupture disc is blown by pressure, it indicates that pressure has gone higher than the safety valve set pressure, which is not possible if the safety valve is operating properly.

2. The thermocouple tube shut-off valve should be kept shut except when reading the gauge, as the joint between tube and valve is a potential source of leakage. It is well to read the first with the valve closed, then open the valve and read again. A drop in indicated pressure, when the valve is opened, shows a leak between the tube and the valve. (A leak in the tube would act the same way, but is a less likely occurrence.) If there is a leak here, re-seal the threaded joint.

3. A faulty tube will not move off atmosphere when read. The tube contains two circuits: the heater filament and the thermocouple. Conceivably either one can break, but the common failure is the heater filament. If the filament is broken or burned out, the gauge cannot be "zero set." The thermocouple can be checked with a continuity meter.

4. A leak across the seat of the vacuum valve, whether from not being closed tight or from a faulty valve, will be indicated by a vacuum between the valve seat and the plug outside the valve. If this is found, then after evacuation, check the rise in insulation pressure overnight with the plug omitted. If there is a measurable rise, reconnect the vacuum pump and pump against the closed valve and check rise in pressure for a similar period. If pressure rises with the outside of the valve at atmospheric pres-sure, and does not rise with the outside of the valve evacuated, there is a leak across the valve seat and the valve should be replaced.

5. If a leak is suspected between the vacuum valve and the vessel, pack thread sealant or vacuum putty around the joint. If this provides a temporary cure, plan to make a more permanent cure at the earliest opportunity.

SECTION V - MAINTENANCE

Re-evacuating the Vessel

The insulation space should be re-evacuated any time the pressure gets "too high." What pressure is "too high" cannot be exactly defined. During manufacturing, tanks are evacuated until the vacuum level is approximately 50 microns. During storage and shipment the vacuum level may rise, especially during the day with direct sunlight on the tank. To obtain an initial good vacuum level, take a reading first thing in the morning. If the warm* vacuum (*before tank has been filled with liquid oxygen or nitrogen) is above 150 microns on a new tank, there may be a problem.

When the tank is initially filled with liquid oxygen or nitrogen, there will be a significant drop in vacuum. It is not unusual for a warm tank at 100 microns or higher to drop well below 50 microns after being cold for 2 or 3 days.

The following are general guidelines for vacuum levels and suggested action:

Status	Vacuum	Action
New - prior to filling (warm tank)	150 microns or less	None
	Above 150 microns	Re-evacuate
New - after initial fill (cold tank)	100 microns or less	None
	101 microns or higher	Re-evacuate
In-service (cold tank)	150 microns or less	None
	Above 150 microns	Re-evacuate

Note that the driving factor in determining when to re-evacuate is "how the tank is behaving." Even with a higher than desired vacuum, the usage may be frequent enough that the higher heat leak due to a higher vacuum has no detrimental effect on the tank. In other words, if the pressure build system must be opened to raise the tank pressure each time it is used, lowering the vacuum will not improve the performance. On the other hand, if tank pressure rises above the operating pressure between uses, then lowering the vacuum would be advisable.

Evacuation of Perlite tank insulation is normally done with a mechanical vacuum pump. The pump should be equipped to prevent backflow of pump fluid into the converter in case of power failure. A solenoid valve or electropneumatic vacuum valve in the pumping line will do this and will also stop loss of tank vacuum. A trap in the pumping line, large enough to hold the pump's entire fluid charge, will prevent fluid backflow but will not prevent loss of tank vacuum.

For re-evacuating a cold tank, a compound pump of 8 to 10 cfm capacity is suggested. For a warm tank, where pressures are likely to be higher and gas volumes are likely to be larger, a single-stage pump of 20 to 30 cfm capacity is more suitable.

In either case a suitable flexible hose is needed. This can be either flexible metal or reinforced rubber.

Connect the pump and hose to the tank evacuation valve, start the pump and evacuate the line; then slowly open the tank evacuating valve. It is desirable to have a thermocouple tube at the pump, and to check that the pump and line blank-off is as low as they should be, before opening tank valve.

The thermocouple gauge can be used while pumping to get an idea of progress. Sometimes there is an appreciable gradient within a tank insulation space while pumping: when the pumping is stopped, pressures equalize and pressure at the tube may increase. Therefore, when evacuation appears complete, close the evacuating valve, wait 10 minutes, and reread the gauge. If there is no change, evacuation is complete.

Replacing Thermocouple Tube

Close the gauge shut-off valve. In unscrewing the old tube, be very careful not to disturb the joint on the other side of the valve. Put thread-sealant on a new tube (starting one thread from the open end) and screw it into the valve. Again, be careful of the joint behind the valve. (Note: Teflon tape is a good sealant for most pipe thread joints, but it is useless on vacuum joints.) Check for leakage.

Replacing Jacket Safety O-Rings

On tanks for atmospheric gases, it is entirely practical to replace O-rings while the tank is in service.

To get to the jacket safety head, a ladder should be placed between the front lifting lug and the ladder lug on the top head. The ladder should be securely tied.

Break vacuum with dry nitrogen, lift off the safety head cover, and remove the old O-rings. Be careful not to scratch the groove surfaces. Carefully clean the O-ring grooves, the sealing surface of the cover and the new O-rings. Coat the new O-rings with a very thin layer of vacuum grease, place them in the grooves, and install the cover concentric with the grooved flange. Hold the cover down until there is enough vacuum to hold it.

Replacing Rupture Disc

On this converter, the rupture disc safety head is a "throw-away" type: the entire 1/2" MPT brass unit is removed and replaced. Close pressure build valve (V-3) and open vent valve (V-13) and allow tank to vent to atmospheric pressure.

Unscrew the safety head, using two wrenches to avoid excess strain on the inlet piping. Install a new safety head using a suitable thread-sealant on the inlet side of the "throw away" assembly.

See that outlet is aimed at the ground under the tank, close vent valve, and open pressure build valve to build pressure in the tank. Check inlet for leaks.

Replacing Inner Vessel Safety Valve

In order to replace the inner vessel safety the tank must also first be vented to atmospheric pressure. Open the manual vent valve (V-13) and allow tank to vent. (NOTE: Make sure pressure build valve (V-3) is closed.

Unscrew the short outlet tube from the safety valve and unscrew the safety valve from the inlet fitting, using two wrenches to minimize the strain on inlet piping.

Put suitable thread sealant on the inlet threads of the new safety valve and install safety valve, again using two wrenches. Install outlet tube in safety valve, aiming it down and under the tank.

Close the vent valve (V-13) and open the pressure build valve (V-3) to build pressure in the tank and check the inlet of the safety valve for leaks.

Replacing Line Safety Valves

Isolate the safety valve by closing appropriate manual valves. (Be sure this won't unnecessarily upset your customer's operations.) Bleed the line section by use of the corresponding bleed valve. Remove the safety, using one wrench on the safety valve and another on the fitting. Install new safety valve, using suitable thread sealant and again using two wrenches to avoid twisting piping. Reopen manual valves closed above, and, check for leaks.

Replacing Pressure Gage

The tank pressure gauge is mounted on the liquid level gauge. Close both gauge line shut-off valves and open the by-pass valve. Carefully loosen pressure gauge, wait for the pressure to bleed off, and remove the pressure gauge. Apply thread sealant to new pressure gauge and install in contents gauge. Open shut-off valves, close by-pass valve, and leak-test joint.

Replacing Contents Gage

The contents gauge is U-bolted to a short pipe welded to the left side of the vacuum jacket approximately at eye-level.

Close both gauge line shut-off valves and open by-pass. Loosen tube nuts at under side of gauge, wait for pressure to bleed off, and disconnect tubing.

Remove pressure gauge, by-pass valve and fittings from old contents gauge and install on new one, using Teflon tape or other suitable thread sealant. If possible, bench-test these joints for leaks before installing on tank. Remount gauge on pipe and reconnect tubing to contents gauge.

With by-pass valve open, open gas side shut-off and check joints for leaks. When all joints are tight, close by-pass and open liquid side shut-off.